Expeditionary Warfare Conference

Mr. Kenneth Moritz
V-22 Joint Program Office
19 Oct 2004

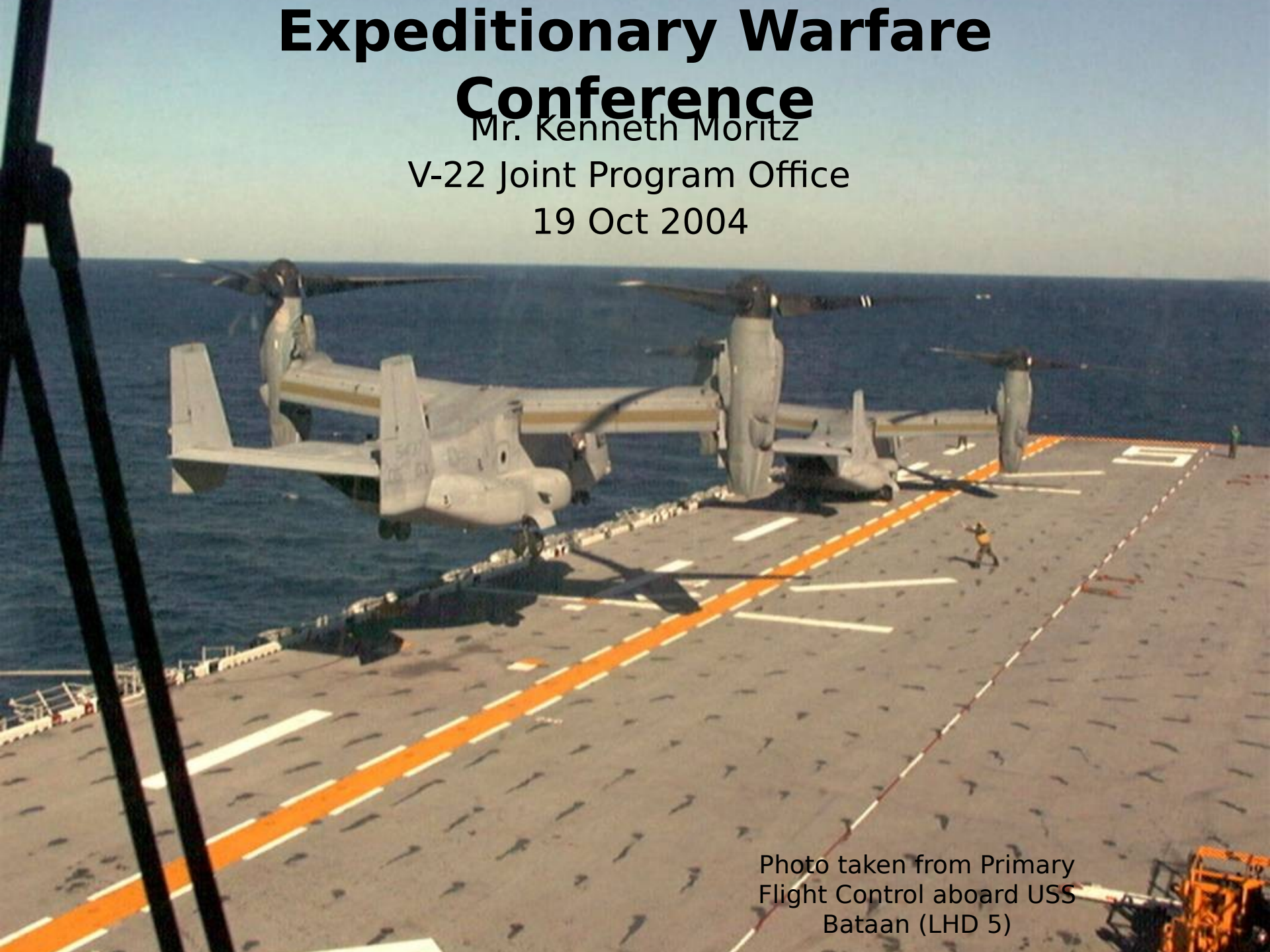


Photo taken from Primary Flight Control aboard USS Bataan (LHD 5)

Agenda

- Film clip Flight of the Osprey
- Joint Service program of record
- MV & CV Descriptions
- Performance
- Reliability, Survivability, Vulnerability
- Spiral development timeline
- Developmental & Operational Testing
- Roadmap to full rate production

Flight of the Osprey

Film Clip

Multi-Mission Tiltrotor Aircraft

Joint Service

USMC

AMPHIBIOUS ASSAULT

SUSTAINED LAND OPERATIONS

SELF-DEPLOYMENT

360 MVs

USSOCOM

LONG-RANGE SPECIAL OPERATIONS

CONTINGENCY OPERATIONS

EVACUATIONS AND MARITIME SPECIAL OPERATIONS

50 CVs

USN

PERSONNEL RECOVERY

FLEET LOGISTIC SUPPORT

SPECIAL WARFARE

48 MVs

MV-22 Description

- Block A – Safe and Operational
  - Line clearance improvements
  - Flight control software changes
- Block B – Enhanced Maintainability
  - Effectiveness and suitability improvements for the fleet
- Block C – Preplanned Product Improvements

CV-22 Description

- Multi-mode Terrain Following / Terrain Avoidance Radar
- Additional internal fuel
- Suite of Integrated RF Countermeasures
- Directional IR Countermeasures (Laser Turrets)

MV & CV Commonality

- Airframe 90%
- Avionics 20 - 40%
- Propulsion 100%

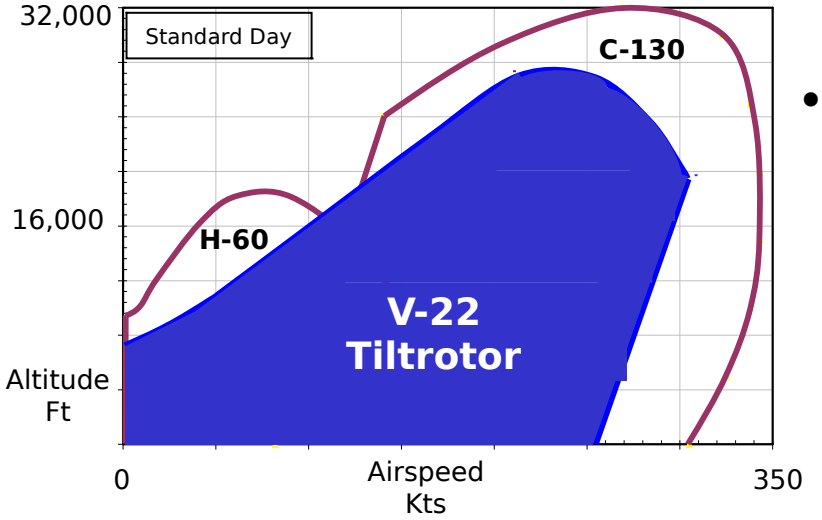
V-22 General Description

Medium lift replacement for CH-46E and CH-53D

Versatility of a helicopter….

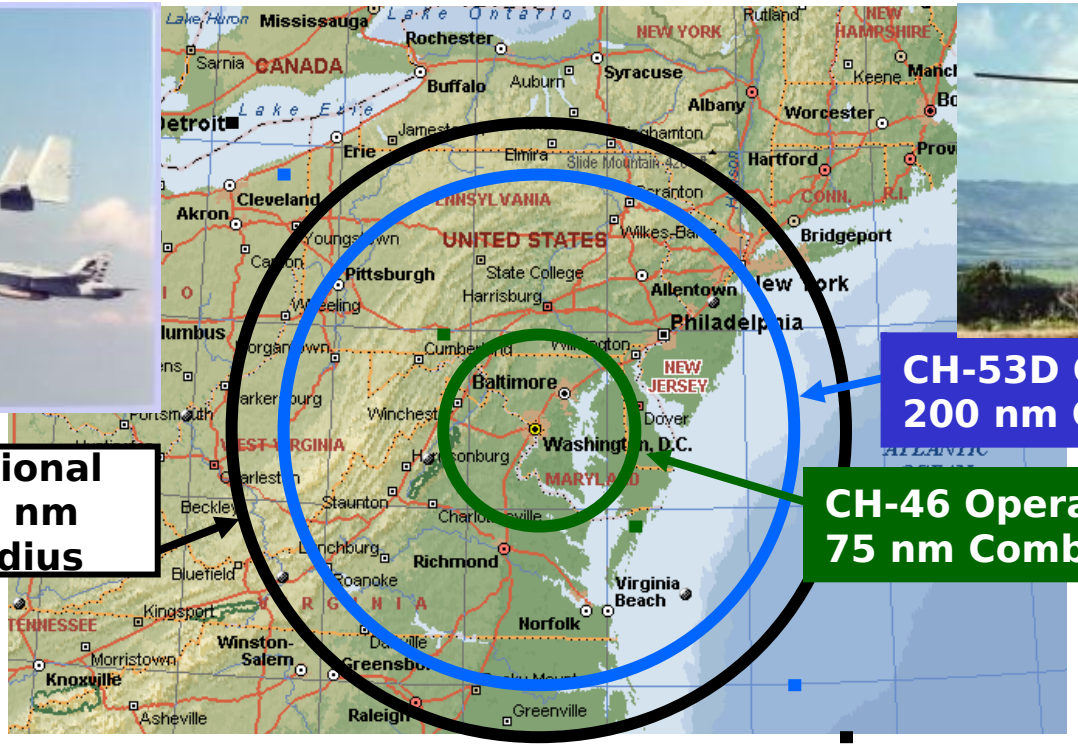
+

…. with the speed and range of a turboprop



- **Plus significant operational enhancements**
  - Susceptibility and vulnerability reductions
  - Frontline survivability
  - Reliability and maintainability improvements
  - Availability and Dependability

MV-22 Mission: Vertical-lift, assault support of combat troops, supplies, and equipment



V-22 Operational Limit 240+ nm Combat Radius

CH-53D Operational Limit 200 nm Combat Radius

CH-46 Operational Limit 75 nm Combat Radius

Lifting a 975-Marine Battalio

Landing Zone Distance 75 nm

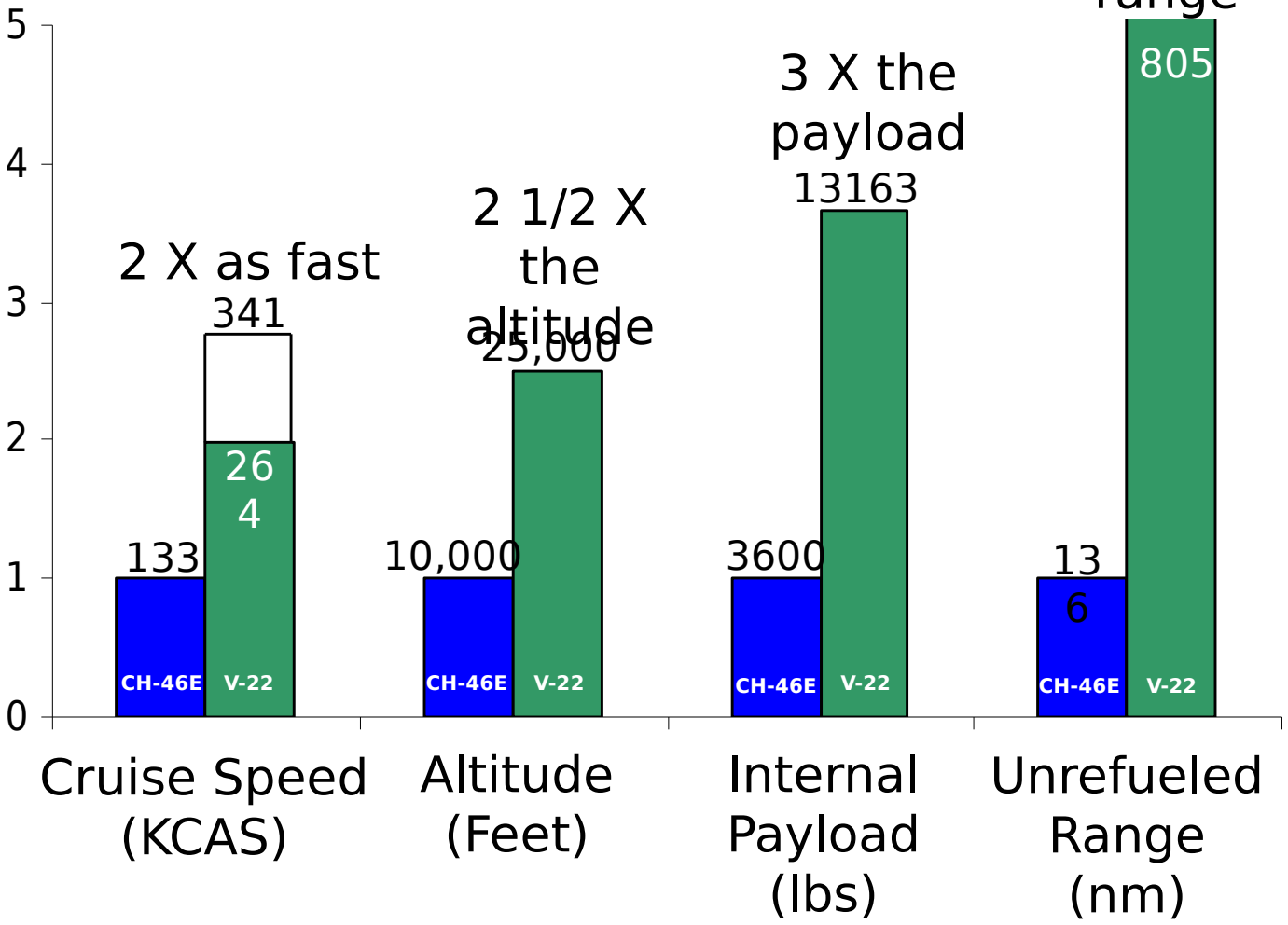
CH-46	**MV-22**
Sorties: 82	Sorties: 41
12 Aircraft: 8-9 waves	12 Aircraft: 4 waves
≈ 16 hrs	**≈ 8 hrs**

Landing Zone Distance 200 nm

CH-53D	**MV-22**
Sorties: 41	Sorties: 41
12 Aircraft: 4 waves	12 Aircraft: 4 waves
≈ 16 hrs	**≈ 8 hrs**

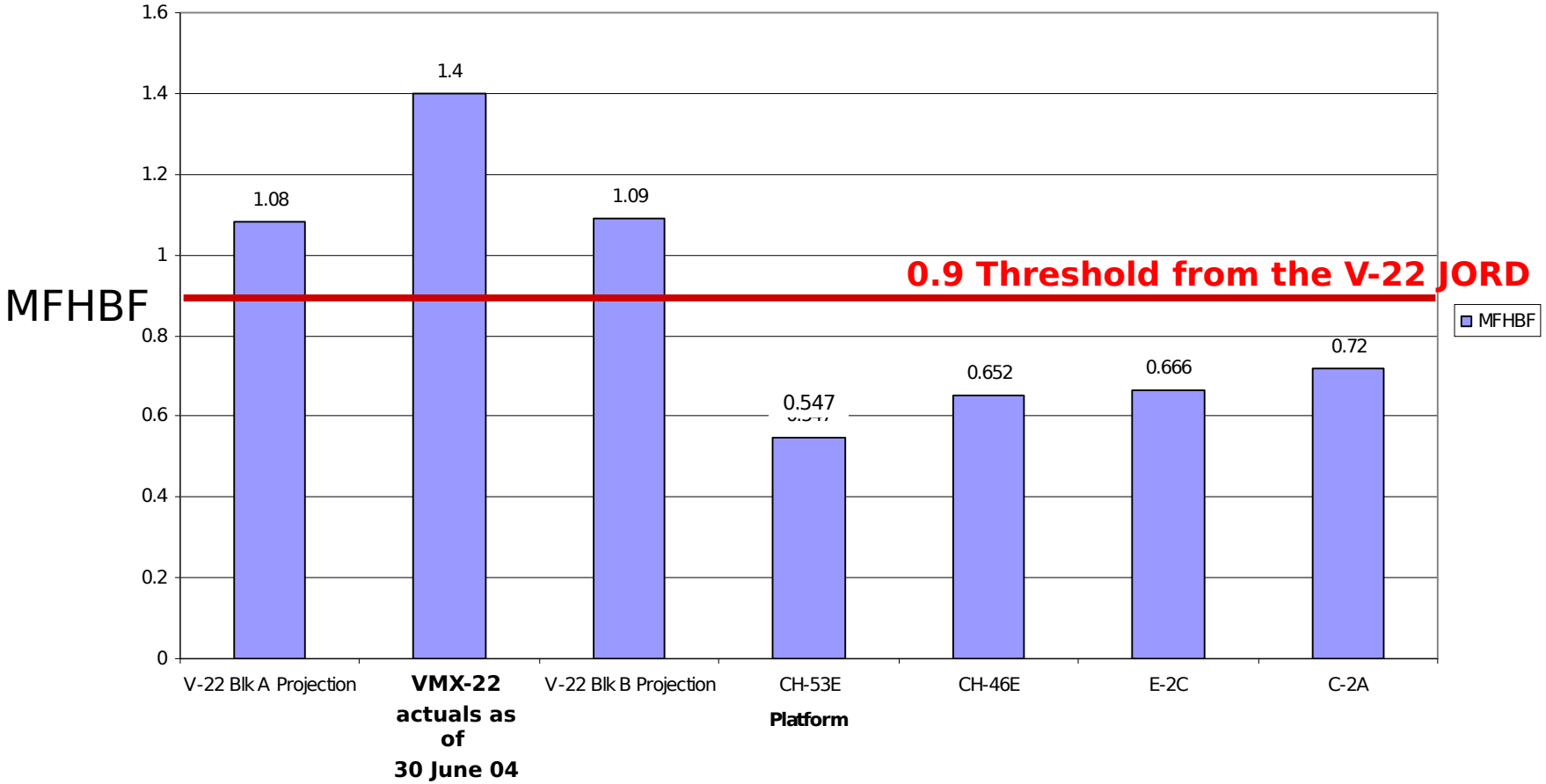
MV-22 vs CH-46E

Performance Comparison w/ wet wing mod



Reliability

MV-22 Blocks A and B Compared to Other Platforms

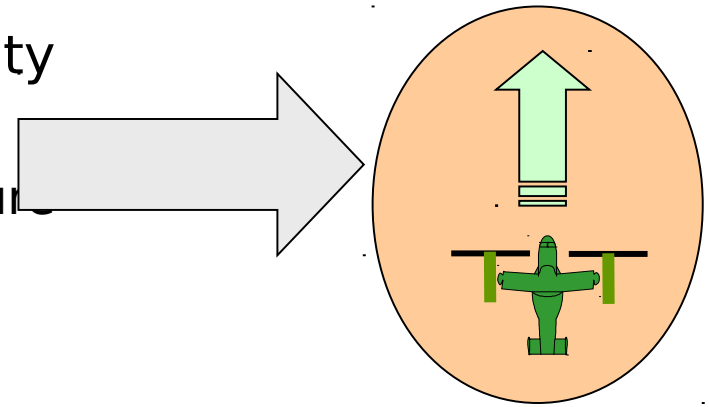


Platform

Survivability

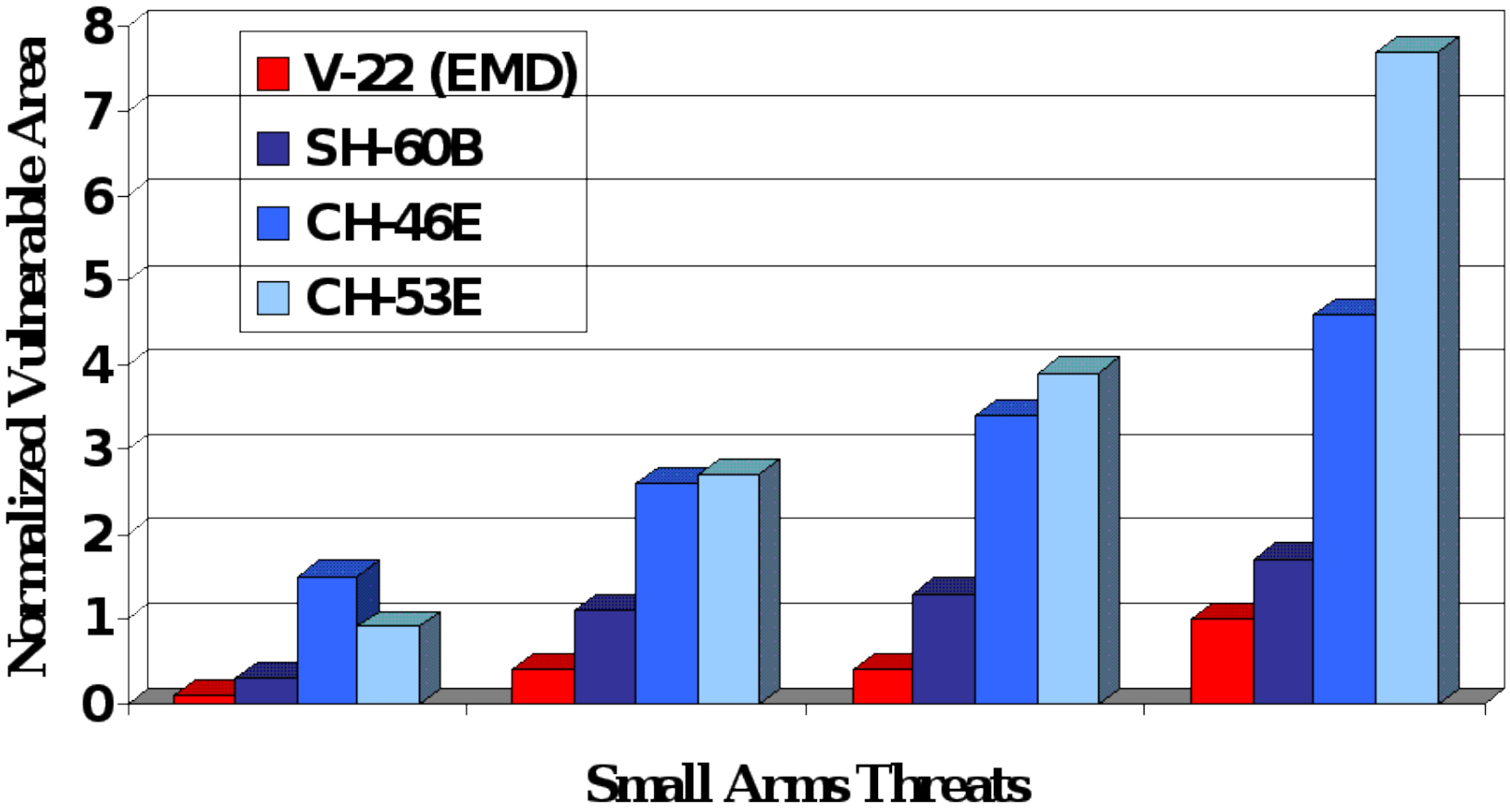
- Susceptibility - probability of being engaged
  - Threat avoidance
    - Advanced threat warning and situation awareness displays
    - Range enables routing around threats
  - Reduced engagement opportunity
    - 95% reduction in IR signature
    - 75% reduction in acoustic signature
    - More than twice the speed
- Vulnerability - probability of surviving a hit
  - High ballistic tolerance
  - Redundant systems

90% Reduction in Adversary Reaction Time



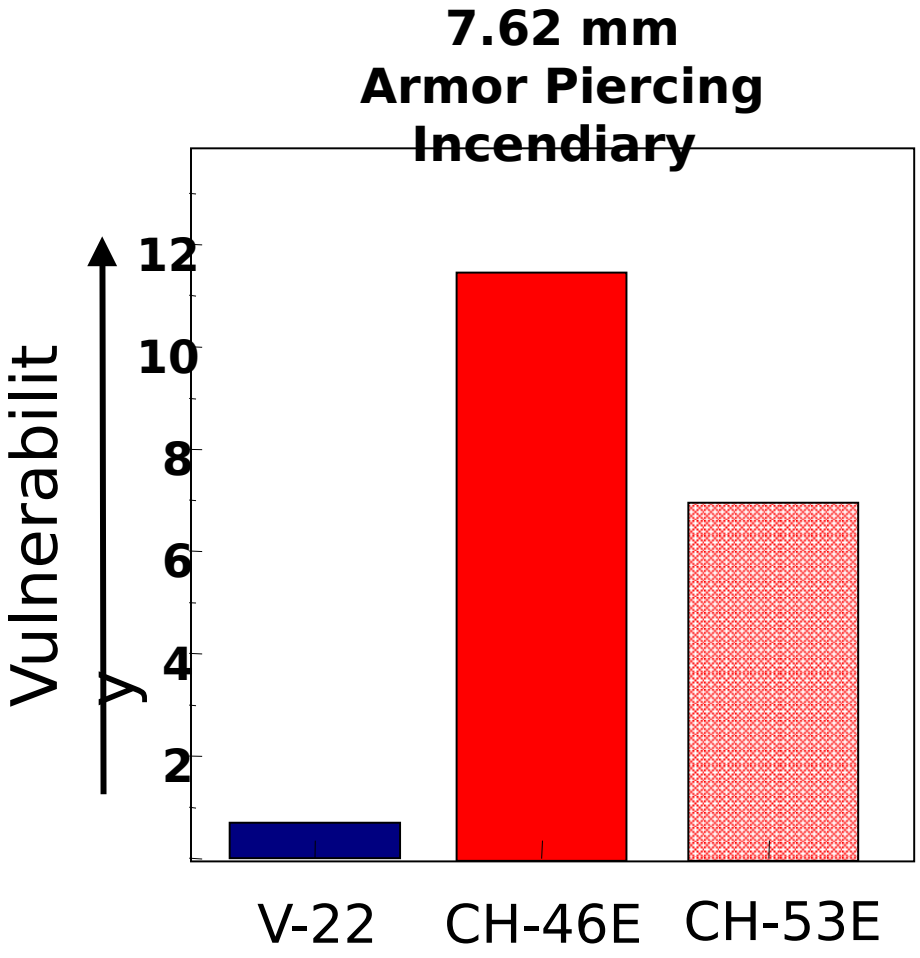
MV-22 - able to go “in harm’s way” and survive

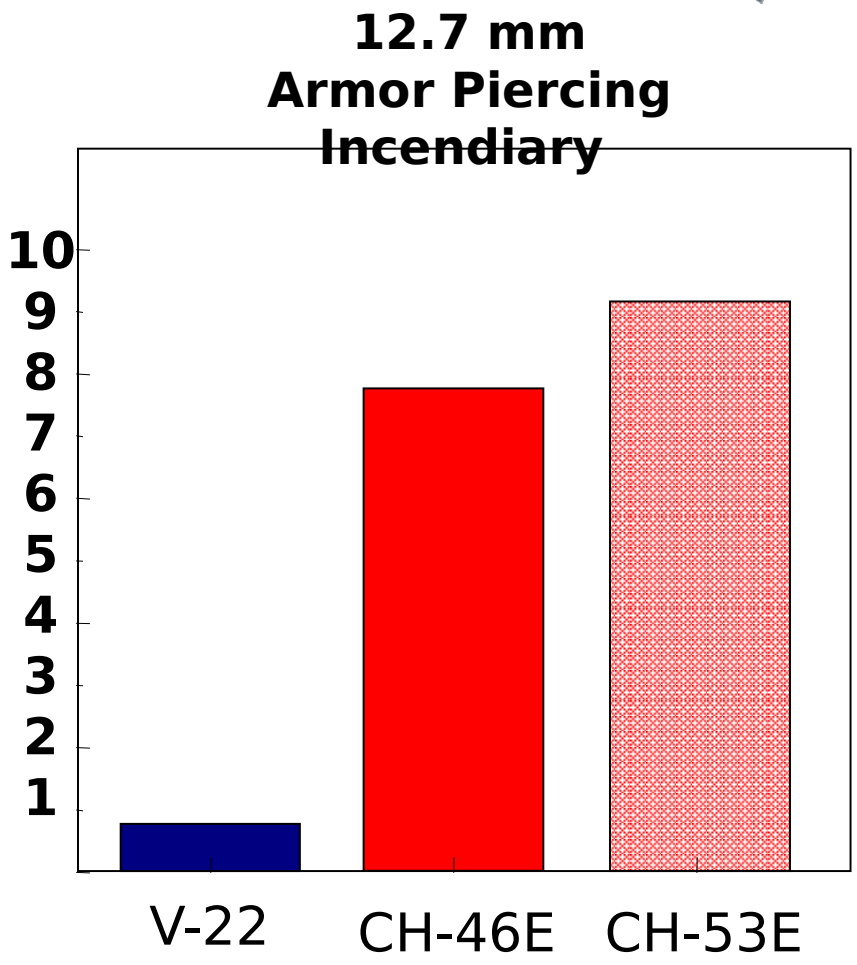
Vulnerability Comparison



Most Extensive Live Fire Testing in NAVAIR

Reduced Vulnerability to Fire





V-22 Program of Record

POM06 Drivers

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
MV-22													
Development													
Block A Safe & Operational					FOT&E								
Block B Enhanced Maintainability									FOT&E				
Block C Mission Enhancements													
			OT IIF	OPEVAL II									
T&E													
					MS III	IOC							
Delivery													
Block A													
Block B Production													
Block B Mod/Retrofit													
Block C													
CV-22													
Development													
Block 0/10 MMR/SIRFC/DIRCM						IOT&E							
Block 20 Mission Enhancements													
			ATA	PRTV 1	2				FOT&E				
								IOC					
Delivery													
Block 0/10													
Block 20													
	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8	Lot 9	Lot 10	Lot 11	Lot 12	Lot 13	Lot 14	Lot 15	Lot 16

Time Now

DT: Aggressively Kicking Over Every Rock

Pax

- 7 MV-22s
  - Flight control system software
  - Line Clearance
  - HROD
  - Low airspeed combat maneuverability
  - Shipboard compatibility (incl roll on deck)
  - Emergency landing profile demo
  - Aerial Delivery
  - Ice Protection System
  - Formation flight

Edwards

- 2 CV-22s
  - CV performance
  - Terrain following
  - Suite of Integrated Radio Frequency Countermeasures

Safe, Methodical, and Event Driven – 1807.5 hours

OA vs OPEVAL

Comparison

OA (OT-IIF)

- Event driven
  - Started 18 May; Completed on 2 July 04
- 3 acft – 120 + flt hrs
- Limited scope
- Test areas
  - Day / VMC
  - IAW publi[illegible]d restrict[illegible]s
- Risk r[illegible]ction for OT-IIG

COTF Final report Issued

OPEVAL (OT-IIG)

- Event driven – 5 months
  - Jan to May 05
- Up to 8 acft – 400+ flt hrs
- Complete formal evaluation
- Test to TEMP / JORD
- COTF recommendation to Milestone Decision Authority "Effective and Suitable" supports M/S III decision (Nov 05) & Sec 123 certification

OT-IIG

1 Wk 2 A/C

1 Wk 8 A/C

Test Aircraft

NEW RIVER
- Final OPEVAL training
- Non-scenario JORD, KPP and specific events items if req'd.

3 Wks 8 A/C

Shipboard 2-3 A/C for Risk Mitigati

Self-deploy

MCAS Yuma
- Scenario based Asslt Spt, Tactics, Self-deploy, and Interoperabilit y

4 Wks 8 A/C

Bridgeport
- Environmental Compatibility, Cold TTP development

1 Wks 2 A/C

China Lake
- Scenario based Survivability, TTP development

4 Wks 8 A/C

Self-deploy

Shipboard
- Shipboard JORD profiles
- Scenario based testing andTTP development

2 Wks 8 A/C

MCAS New River for Test clean-

Met or Fully Completed & Validated thru Additional OT

1999 2000 2001 2002 2003 2004 2005

J J J J J J J A J O J A J O J A J O J A J

Complete Software Review/ Process Improvements

Shipboard H-46, H-53

Shipboard V-22/V-22

VMX-22 LOO

Continued Triple Lab Testing

Multiple V-22, C-130

H-1, H-46, H-53, F-18, C-130, V-22

VMX-22 allow troops on aircraft

VMS 11.4.1

Shipboard H-1

C-130 AR

FORM

JITC

OT-IIE

RTF

OT-IIF

OT-IIG

DT-IIE

DT-IIF

OPEVAL Report

Sect 123

Flight Readiness Review

Grass/Dirt Austere

Lightweight Howitzer Lift

Quick Look

External Loads

OPEVAL Buildup

Externals, Fastrope SPIE, Aerial Delivery

BLRIPReport

OT-IIF OTRR

Most stringent line clearance standards in Aviation

Cargo Aerial Delivery

Desert Ops

SECDEF Certification

Block A Begins

Austere Technique Development

OPEVAL Report

Identification of Block A Requirements to Meet R&M Values

In-depth Line Clearance Inspections

OT-IIF Report

DT/OT R&M Data Collection

OPEVAL OTRR

DT **OT**

Questions?

Back Up

V-22 Osprey and Sea Power 21

Marine Expeditionary Concepts

- **Sea Basing and Sea Shield**
  - Operational Maneuver From the Sea
  - Sustained Ops Ashore
  - Maritime Preposition Force Future

DT / OT Transition

JPO

- DT pilots / maintainers
- Engineering development
  - FQ&P
  - Mission software
  - Logistics system
  - Operating envelope

VMX-22

- OT pilot / maintainer feedback
- R&M data

Open Communications – Key to Success

Road to FRP

NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT

Congress Budget Cycle

HBC

SAC

HAC

Staff Briefings

In Conference

Public Law

OSD

DOT&E Report to Congress

BLRIP

FRP/MSII

Communicate to Leadership

Sec 123 cert ltr

Develop CPD

oint Staff / Services

Prepare Program Brief for Congressiona l Staff

Respond to Staff Requests

MSIII / FRP PREP

JPO

Aircraft Delivered

Aircraft Ready / Flight Clearance

Pre- OTRR

OTRR

Manufacturing Preparedness

OPEVAL Updates

COTF/ VMX

OT-IIG Report

Qualifications / Training

OPEVAL OT-IIG

MV-22 Performance

MV-22 Mission Performance Summary				
SD-572 Mission	**KPP**	**Thresholds**	**@ Block A Projected Wt**	**Remarks**
Land Assault - Ext Cargo	X	50 NM	**63.3 NM**	
Land Assault - Troops		200 NM	**245.9 NM**	
Amphib Assault – External Cargo		50 NM	**130.1 NM**	
Amphib Assault - Troops		50 NM	**82.2 NM**	
Pre - Assault Raid	X	200 NM	**268.6 NM**	
Self – Deployment (3 x 430 gal)	X	2,100 NM	**2,384 NM[1]**	With Block B WAT, MAT kits
Max MCP Cruise Speed	X	240 KTAS	**264.8 KTAS**	

[1]Pending latest performance estimate with forward MAT only 80% full

Above 5 % Margin | **0 – 5 % Margin** | **Below Threshold**

Ref: Jul 04 Aero/Perf Summary

CV-22 Performance

CV-22 Mission Performance Summary				
SD-572 Mission	**KPP**	**Thresholds**	**@ Block 0/10 Projected Wt**	**Remarks**
Special Operations Mission Radius	X	500 NM	**556 NM[1]**	Change in MAT design
Self-Deployment (2 x 430 gal)	X	2100 NM	**2251 NM**	Retractable Air Refueling Probe
Max MCP Cruise Speed	X	230 NM	**236.5 KTAS**	
Operational Environment	X	300 ft. TF/TA VMC/IMC		Currently testing 200' airplane/100' conv mode TF
Operational Environment	X	DECM (SIRFC RWR)		DIRCM, SIRFC jamming
Interoperability	X	Satisfy Top Level IERs		
Payload (Troops/Cargo)	X	18/8000		

[1]Pending latest performance estimate with forward MAT only 80% full

Ref: Jul 04 Aero/Perf Summary

Above 5 % Margin | **0 – 5 % Margin** | **Below Threshold**

July 2004 ADM Tasking

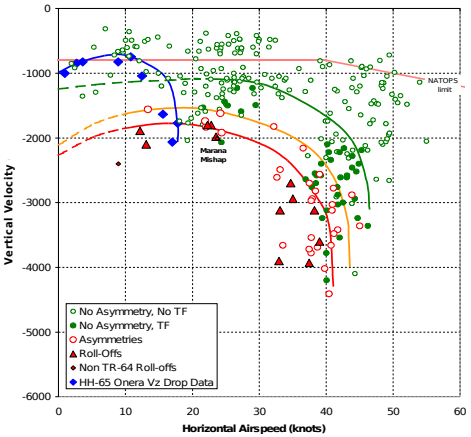
"The Navy shall propose to me through the OIPT, metrics that will accurately indicate program progress towards Secretary of Defense certification required by Section 123 of the National Defense Authorization Act for Fiscal Year 2002"

Flight Test Accomplishments

Line Clearance Inspections

High Rate of Descent

dependent on GW & density ratio



Sea Operations

Combat Maneuverability

Aerial Cargo Delivery

Flight Test Accomplishments

External Loads

Austere Landings

TF / TA and SIRFC

Critical Azimuth

- Production Facilities
  - Philadelphia, fuselage build
  - Amarillo, Ramp & Final

- MCAS New River
  - –Operational Test
  - –VMX-22 10 MV-22

- NAS Patuxent River
  - –MV Developmental Test
  - –7 MV-22

- Edwards AFB
  - –CV Developmental Test
  - –2 CV-22

Aerial Delivery

- Thirty-four, 500 lb pallets with varying aircraft CG
- Thirty-four, 1,000 lb pallets with varying aircraft CG
- Conversion and Airplane Mode

Aerial Delivery

Operational Evaluation (OT-IIG)

- Currently Scheduled to begin Jan 2005 (120-150 days)
- Eight Aircraft
- Multi-site
  - MCAS New River, NC
  - MCAS Yuma, Az
  - NAWC China Lake, CA
  - MCMWTC Bridgeport, CA
  - Amphibious shipping
- Current, Qualified and Proficient Aircrew and Maintainers
- Interim Integrated Logistic Support

Sec 123 Comm Plan

NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT

COTF/VMX-22

Sec. 123 LTR OF OBS

OT-IIG Report

Quals/Training

OPEVAL

JPO OPEVAL

OTRR

DT/OT Transition Report

Prep Staffer Brief

Respond to Staffer requests

Sec 123 Cert ltr

OSD

DOT&E Report to Congress

BLR FRP ADM

Congress

Input to Prepared Statements

Hill Staff Briefings

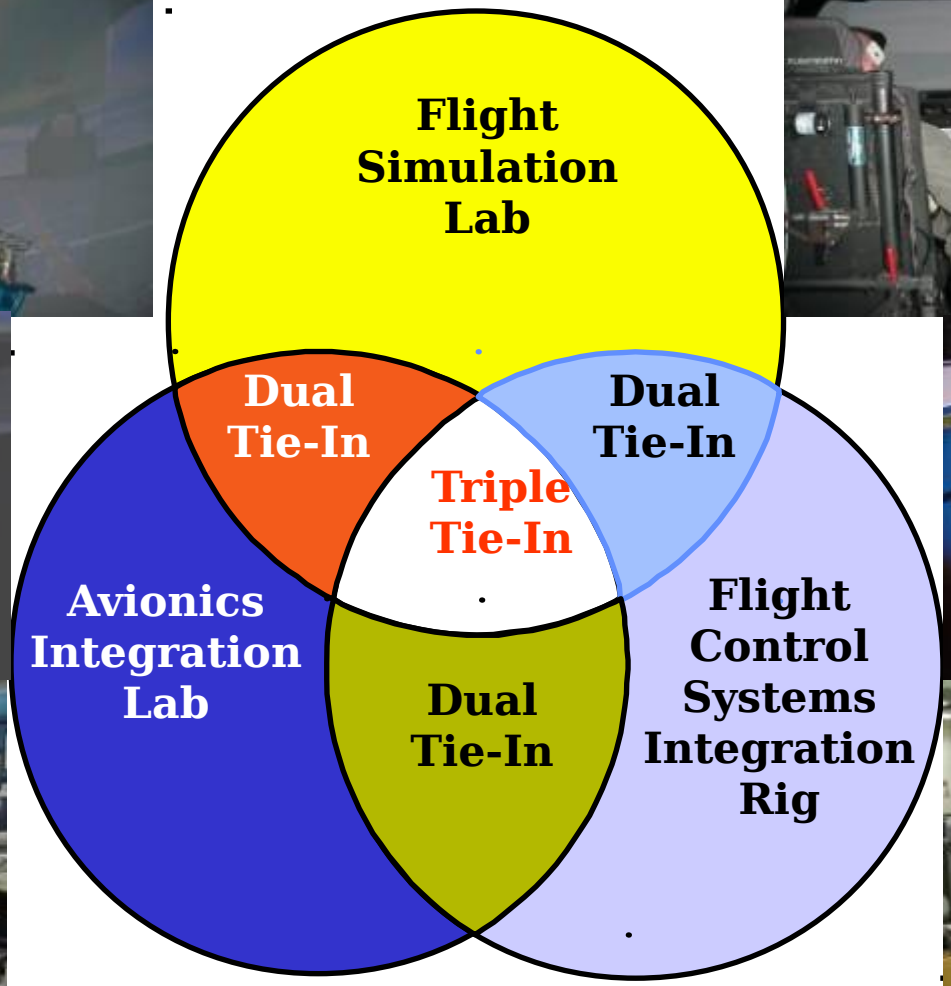
Auth → Appn

In Conference

Public Law

Flight Control System

Boeing “Triple Lab”



- **FCS Software qualification**
- **WCA / EP validation**
- **Degraded Modes flying qualities**

Line Clearance Performance

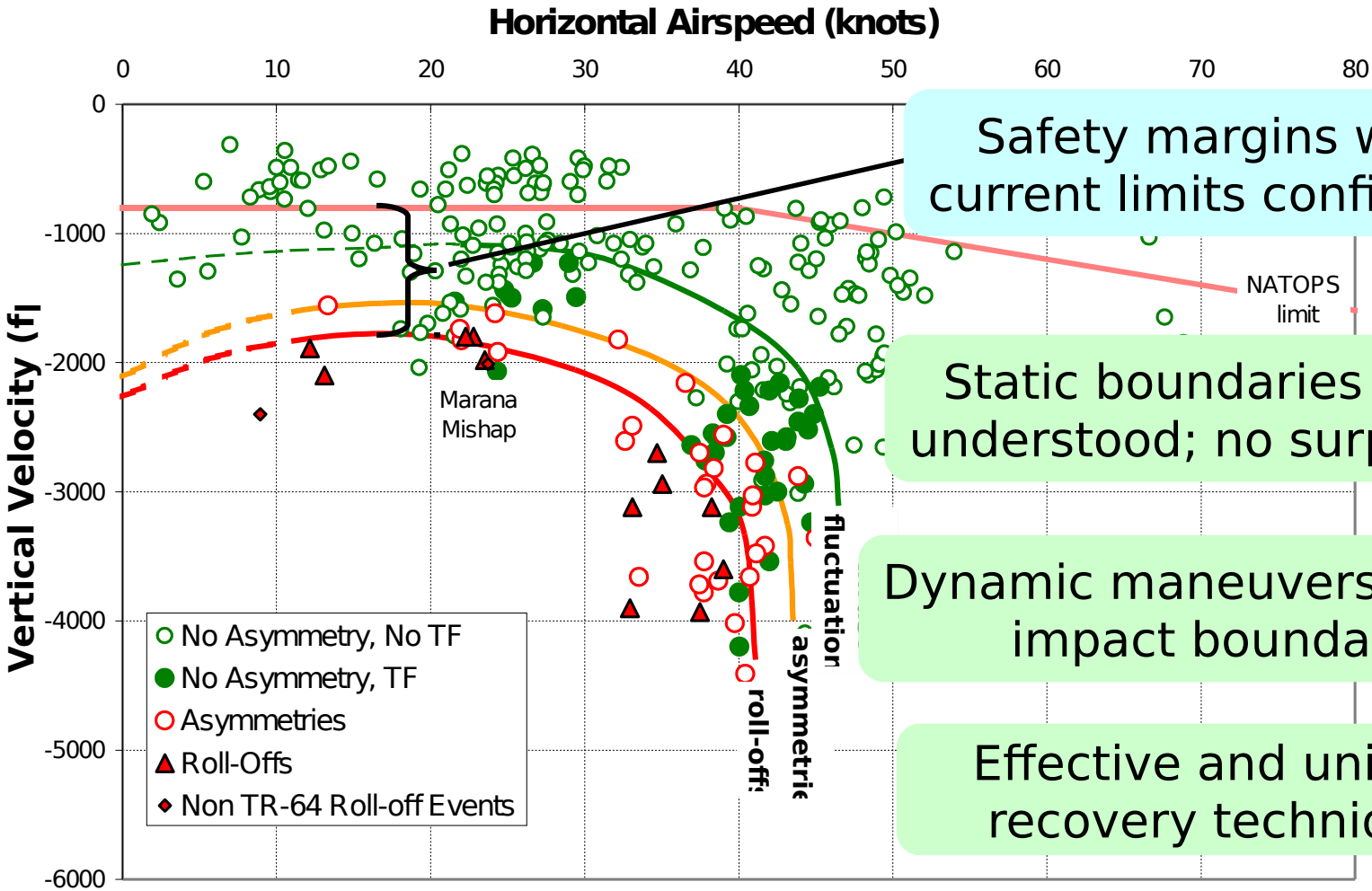
- Established and met unprecedented line clearance requirements
- Design withstanding operating en
- No engine experienced
- Inspection intervals expanded to 70 hours
- Block A further improves on design
  - Component redesign / relocation provides more space in nacelle
  - Graphite-epoxy coating vice tape under clamps

  - Deletion of many click studs
  - Rerouting / reworking of wire harnesses
  - Block A has no unique line clearance inspection requirement

Hydraulic line chafing resolved

Vortex Ring State

(High Rate of Descent)



Safety margins with current limits confirmed

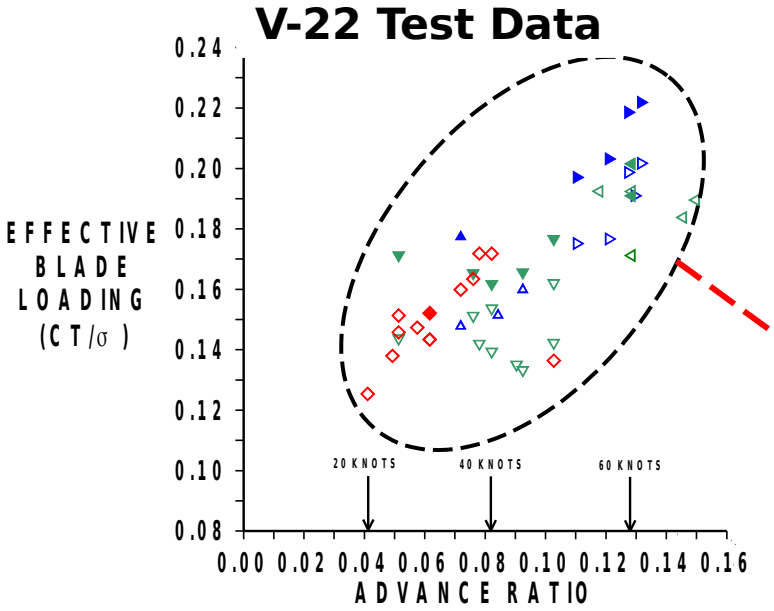
Static boundaries well understood; no surprises

Dynamic maneuvers do not impact boundary

Effective and unique recovery technique

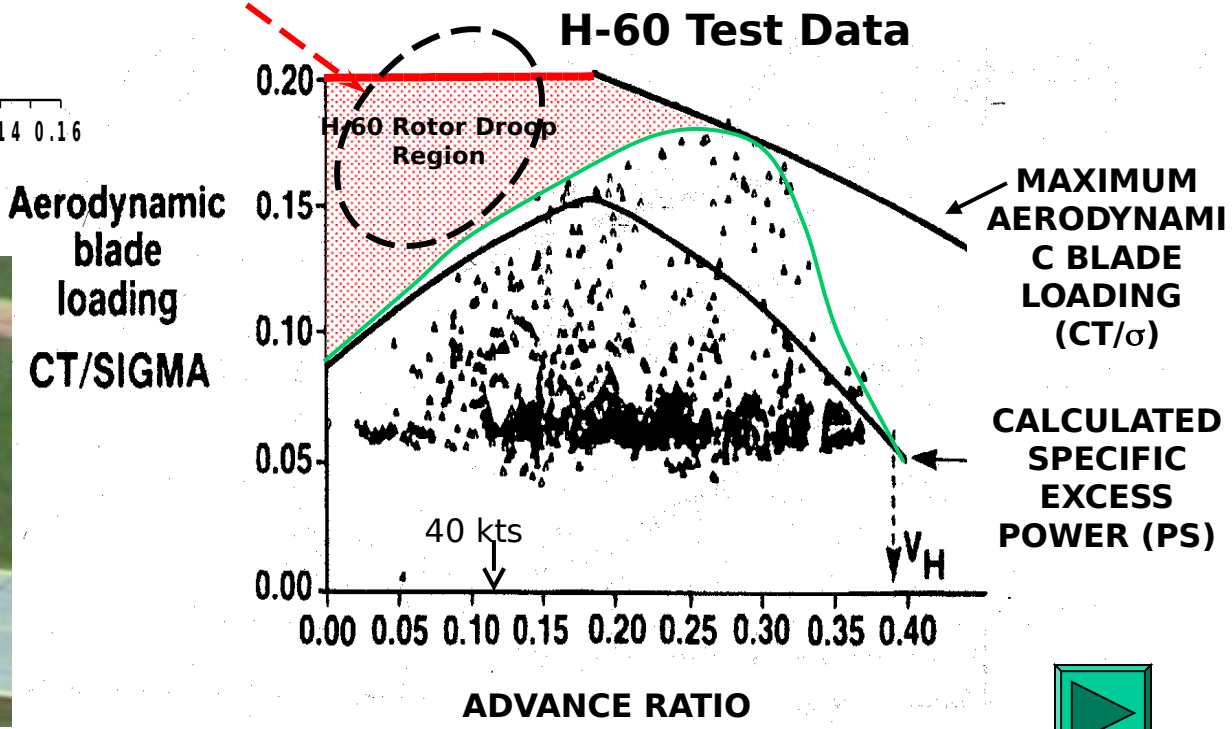
Phase I completed; envelope expansion possible

Combat Maneuverability



V-22 combat maneuverability superior to H-60

- No rotor stall (Droop)
- No loss of roll control



Shipboard Compatibility
(Roll on Deck)

- V-22 is compatible in the shipboard environment
- Refined Flight Control Software to solve roll on deck
  - Increased AFCS authority on deck
  - Flight test validated model indicates positive response in worst case
    - CH-53 one spot forward with 30kt WOD
- November 03 Sea Trial period on USS BATAAN (LHD 5)
  - Results of tests of modified flight control software proved better than predicted
- Next period November 2004 USS Wasp (LHD-1)

Landing Zone Interactions
(Austere Landings)

- Evaluate downwash effects of operating over unprepared surfaces
  - Impacts of dust, sand, debris on V-22 systems
  - Pilot techniques in degraded cueing environment

- Three phase testing
  - ✓ "Quick look" to evaluate single A/C operations in loose soil
  - ✓ Local area testing to evaluate 2 acft operations in grass and loose soil
  - ✓ Combined DT / OT period begins based out of Nellis AFB completed 8 Oct 04

Aerial Delivery

- Thirty-four 500 lb pallets with varying aircraft CG
- Thirty-four 1,000 lb pallets with varying aircraft CG
- Conversion and airplane mode
- Combined DT / OT period for cargo and personnel drops completed on 14 Sep 04
- Personnel delivery HALO jump by Gen Brown (USSOCOM) and team on 8 Oct @ New River

Natural Icing Flight Tests

Nova Scotia, Canada

- Very successful developmental icing season, Nov 03 – April 04
- Results:
  - Cleared to operate throughout entire OAT, liquid water content envelope for second season
  - 19 icing flights, 56 hours of IPS operation, 14.9 hours accumulating ice
  - IPS component reliability good
- Additional testing November 2004 through April 2005 DT /OT icing testing period

Natural Icing Flight Tests

Nova Scotia, Canada

- May-Oct ’04
  - Wing ice shape evaluation
  - Mod – Install Multi-Mode Radar radome anti-ice system
  - Clear air baseline for MMR
  - Inspection / shakedown prep for demonstration next season
- 2005 Season
  - System demonstration across entire icing envelope
    - Airplane and conversion mode
  - Failure mode testing
    - Generators, etc.
  - Maneuver envelope verification
  - MMR anti-ice radome testing (CV-22)

Formation Flight

- Operationally effective flight envelope established and demonstrated
  - Multiple V-22 formation flights
  - Multiple aircraft-type interactions during OT-IIE
    - Integrated multiple aerial maneuver elements
    - FARP
  - Recent section work at Pax
    - Takeoffs, maneuvering, landings

- No issues noted
- Envelope expansion flight testing planned to decrease allowable lateral separation

CV-22 Performance

(as of 10 Sep 04)

- 65.8 Flight hours
- 507 Performance test conditions

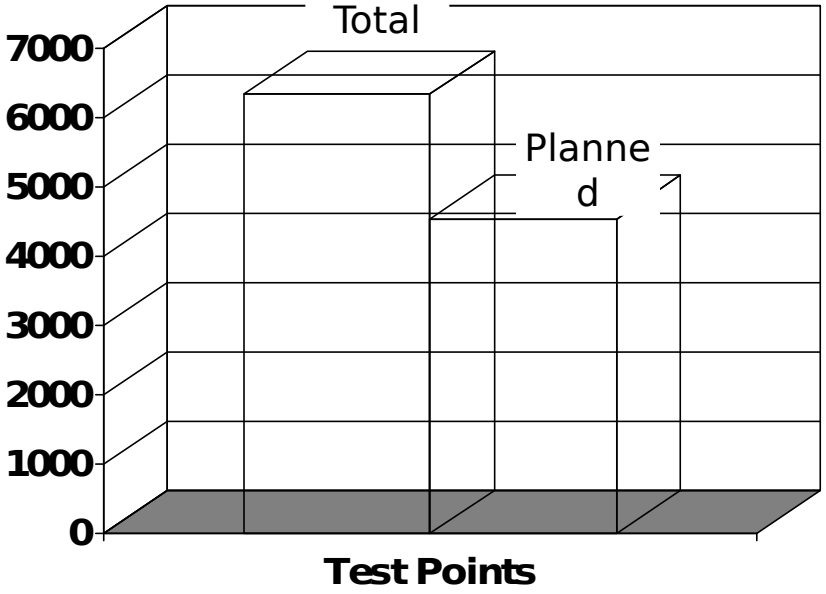
Terrain Following Development

- 199 Multi-mode Radar TF hours flown
- 755 of 3832 planned test points completed (26 Aug 04)
- Accomplishments
  - Low and high isolated peaks in airplane mode
  - Radalt control in TR mode
  - Land / water transitions

BAF Test Results

Period 3 SIRFC and other EW

BAF Entry: 2 Jul 02– On Time



- Flight test is underway
- IOT&E is scheduled to start in mid FY-06

Successful BAF Test Period!

BAF SUMMARY

Period 3

- Verified Radar Absorbent Structure (RAS) design & antenna placements.
- Verified RAS treatments & antenna relocation had desired effect
- Validated significant improvement in AOA accuracy
- Significantly reduced risk for open air testing

Resounding Success

EW Phase I On-Range Testing

- Provided early look at
  - MMR – SIRFC interface
    - Obtained preliminary data
    - Discovered some anomalies requiring more investigating
    - More testing required to evaluate fixes
  - Rotor Modulation
    - Testing completed
    - Results undergoing analysis
  - Angle of arrival/geolocation performance
    - Some minor anomalies but generally correlated with BAF III
  - Wring-out of data collection/analysis procedures and algorithms
    - Critical since each range's data must interface wiht CV-22 data analysis system
  - Exercise of range procedures

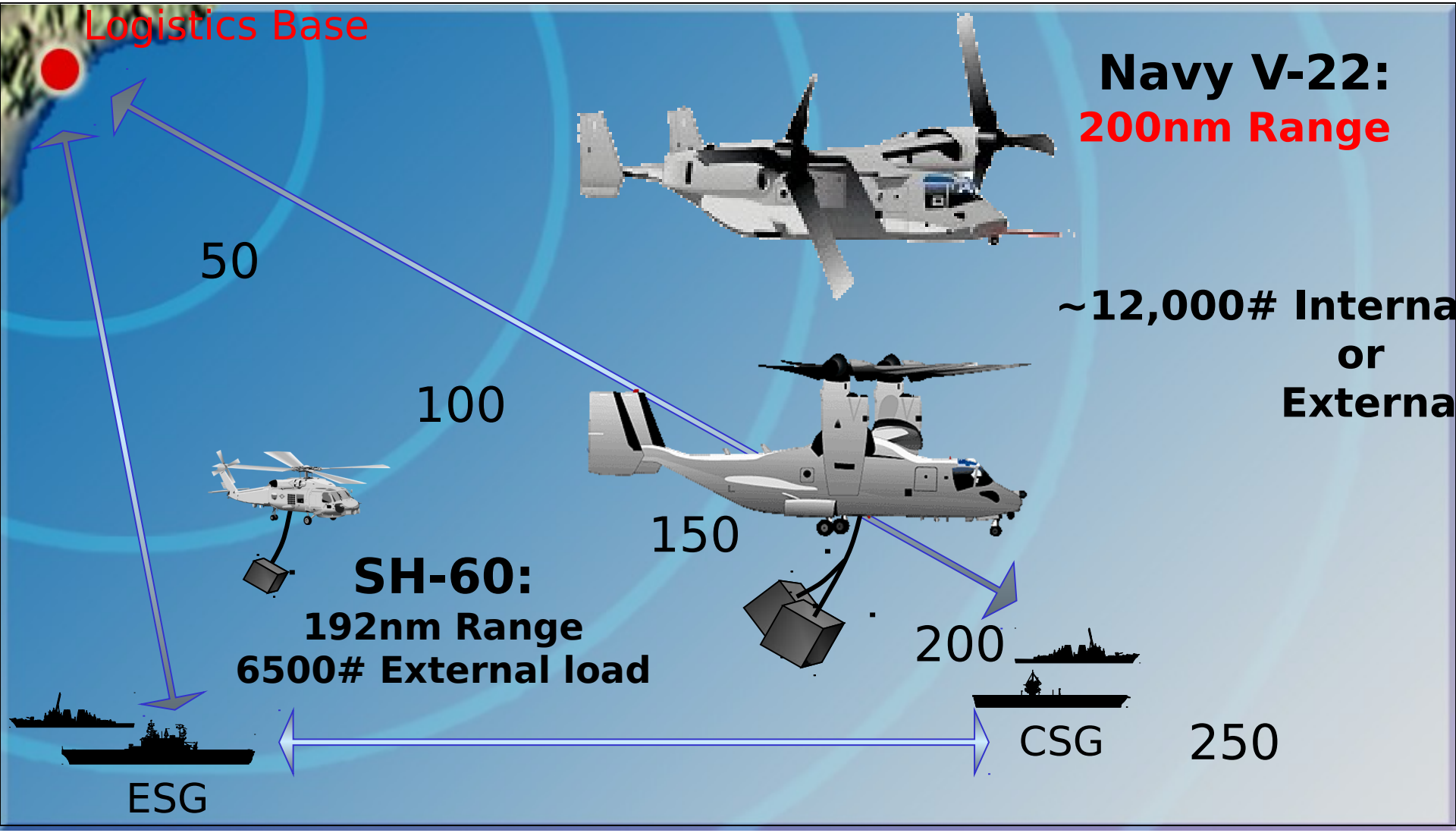
Front Office

Primary Flight Display

V-22 Fundamentals and Unique Characteristics

- 3 different operating Modes
  - VTOL Mode
    Helicopter like
    (with a tilt)
- How Do You Control Nacelles?
- Conversion Mode
  Permissive & Carefree Handling with Boundary
- Airplane Mode
  Transport

Navy V-22: COD / VOD



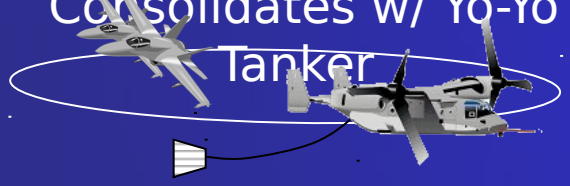
Sea Base Enabler – Speed, Range & Payload facilitate adaptable logistic operations in widely dispersed Sea Base, Releases SH-60 for

Tactical Air Refueling Tanker

Recovery Tanker

Launches last, climbs to 10K

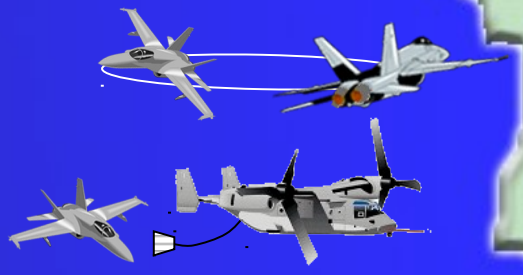
Consolidates w/ Yo-Yo Tanker



Egress Tanker

Meets strike group overhead “Red Crown”

CSG



Close Air Support Tanker

Supports CAS aircraft as required

Strike Support: 10,000# Give..Releases F/A-18E/F for Other Miss

Navy V-22: Search & Rescue

50

100

150

200

Navy V-22:
200nm un-refueled @ 250kts
48 min. to overhead survivor

H-60:
120 nm range limit requires of use “lily pad” for refueling
120min. to overhead survivor

Pilot Ejects 200nm from CVN
Water Temp 46°F

V-22 **H-60**

0.3 0.5 1.0 2.0

3.0hrs

Time of Useful Consciousness **Survival Doubtful**

Reducing survivor exposure time is key to su